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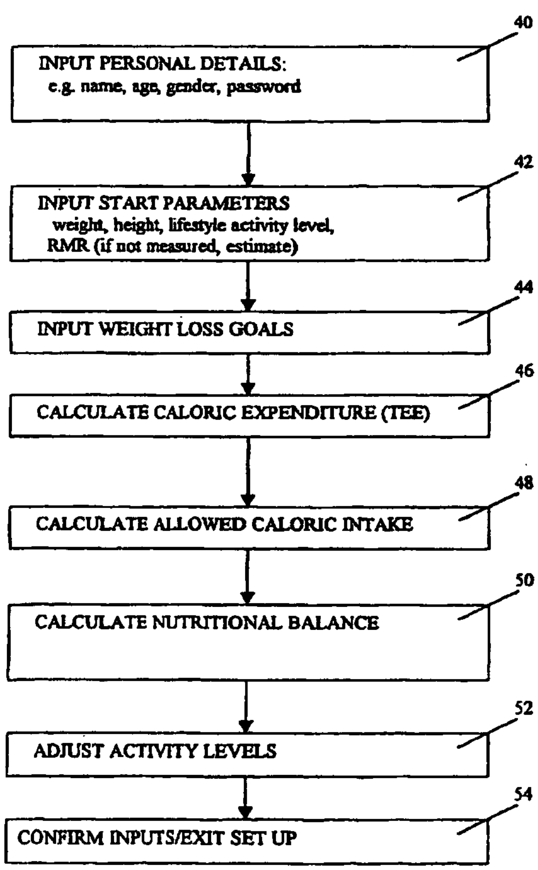
(54) Title: HEALTH MANAGEMENT SYSTEM WITH CONNECTION TO REMOTE COMPUTER SYSTEM



(57) Abstract: An improved health management system and method are described. A user is provided with a portable microprocessor-based device, which has an application program adapted to receive user input data (40-54) related to caloric intake and caloric expenditure. An application program on a remote computer receives the data and analyzes the data to provide feedback and advise the user.

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HEALTH MANAGEMENT SYSTEM WITH CONNECTION TO REMOTE COMPUTER SYSTEM

Field of the Invention

The invention relates to health management, in particular to diet management and weight control.

Background of the Invention

There are serious problems with conventional weight loss programs. Food consumption by the person using the weight loss program (the user) is conventionally recorded in great detail, allowing an accurate caloric intake to be determined. However, weight control is related to the user's net caloric balance, the difference between caloric intake and caloric expenditure. Caloric expenditure is usually not known accurately. It is possible to estimate the caloric expenditure related to various physical activities. However, as discussed by Remmereit in U.S. Patent No. 6,034,132, for a typical person, 70 percent of total caloric expenditure is due to their resting metabolic rate (RMR). In a conventional diet program, RMR is estimated from the height, weight, age, and gender of the person, for example using the Harris-Benedict equation. This equation, well known to those skilled in the nutritional arts, is given in U.S. Patent No. 5,839,901 to Karkanen, and in U.S. Patent No. 5,639,471 to Chait et al. There are serious inadequacies in using the Harris-Benedict equation (or any similar equation) in a weight loss program. The Harris-Benedict equation provides only an estimated RMR, which is an average value for

people of similar height, weight, age, and gender. However, due to natural variations in physiology, it need not be accurate for a specific individual.

The total caloric expenditure of a person comprises a resting metabolic component and a physical activity component. Total energy expenditure (TEE) is the sum of resting energy expenditure (REE) and activity energy expenditure (AEE), i.e. TEE = AEE + REE. Weight loss occurs if total caloric expenditure (TEE) exceeds total caloric intake over a given time period. The net caloric balance for a person is the difference between caloric expenditure and caloric intake.

Conventional weight loss programs use an estimated TEE based on estimates of activity levels, and estimates of REE from the Harris-Benedict equation. However, if REE is not estimated correctly, the person's caloric balance cannot be known accurately, and the outcome of a weight loss program is likely to be unsatisfactory.

It is also known that RMR often falls during a restricted calorie diet. The Harris-Benedict equation scales RMR with weight, but does not account for a natural slowing of human metabolism in what the body may interpret as partial starvation conditions. Physical activity during the restricted calorie diet may cause RMR to fall further to allow the body to conserve energy, or, alternatively, it may cause RMR to increase due to an increase in muscle mass. Hence, in addition to unpredictable variations in RMR from person to person, there are also unpredictable changes in RMR in response to a weight control program. The improved weight control system described herein overcomes these problems.

Resting metabolic rate (RMR) can be measured using an indirect calorimeter. REE corresponds to the value RMR multiplied by an appropriate time period, usually one day. (RMR is a rate of energy expenditure whereas REE is a total energy expenditure over a given time period, though REE and RMR are sometimes used interchangeably). Conventional indirect calorimeters are too large and expensive to be used as part of a weight control program. Recently, James R. Mault M.D. et al. invented an improved indirect calorimeter, embodiments of which are well suited for applications in improved weight control and health management programs. The improved indirect calorimeter is more fully described in pending U.S. application Serial No. 09/630,398.

Conventional diet calculators enable food records to be created on a hand-held-device. However, they do not provide a link to a communications network, and so cannot provide feedback generated by a remote computer system, or health professional with access to the communications network.

In U.S. Patent No. 5,839,901, Karkanen describes an integrated weight loss control method, in which a calorie density is determined by comparing the actual weight loss of a dieter to an estimated calorie deficit. This patent does not describe a system in which a person has a portable computing device linked to a communications network.

In U.S. Patent No. 5,639,471, Chait et al. describes the formulation of a nutritionally balanced diet based on a person's caloric requirements calculated using the Harris-Benedict equation. However, this patent does not describe a weight loss program with feedback provided to the person over a communications network, or the determination of a person's caloric balance.

In U.S. Patent No. 5,933,136, Brown describes the controlled access to an entertainment program based on the user's compliance with a treatment plan. However, this patent does not describe the provision of information so as to help the user comply with a weight control program, based on the degree of compliance with the program.

In U.S. Patent No. 6,039,688, Douglas et al. describes a therapeutic behavior modification program. However, this patent does not describe the determination of a person's caloric balance.

In U.S. Patent No. 4,321,674, Krames describes an electronic diet calculator. This hand-held device allows a person to record consumption from a limited selection of food items. In U.S. Patent No. 4,729,479, Duboff describes a diet calculator with key entry, in which consumption is subtracted from target amounts. In U.S. Patent Nos. 5,704,350 and 4,891,756, Williams et al. describes a diet calculator in which foods are grouped by category, and presented to the user using a menu display. In U.S. Patent No. 5,729,479, Golan describes a multifunctional diet calculator, in which cumulative food totals are compared with target amounts. Other diet calculators are described by Sakai (4,855,945), Ikemoto (4,894,793), and others.

Summary of the Invention

It is an object of the present invention to provide an improved weight control system. In a preferred embodiment, the person using the improved weight control program (the user) is provided with a portable computing device, such as a personal digital assistant (PDA). The PDA has a software application program, which for

convenience will be called a calorie management program. The calorie management program comprises the functionality of diet logging software, and enables the user to record food items consumed. The calorie management program preferably has other functionality, so as to assist the user to set and achieve weight goals.

Another object of the invention is to provide a weight control system in which unpredictable variations of resting metabolic rate (RMR) are accounted for. The user preferably measures their RMR using a metabolic rate meter, such as an indirect calorimeter, and enters this value into the calorie management program. The user also enters weight control goals, such as a certain weight loss goal. The calorie management program uses the determined value of RMR to estimate total energy expenditure (TEE), based on an assumed level of physical activity, and determines a level of caloric intake which will enable the weight control goals to be met. During the weight control program, the user records weight, food intake using a diet log, activity levels, and resting metabolic rate at intervals.

A further object of the invention is to provide improved feedback to the user over a communications network. Calorie management data is transmitted from the PDA to the remote computer system. The user connects to the remote server at a convenient time, for example in the evening, and recorded diet log data, weight, and activity-related signals are transmitted to the remote server and stored in a related database. Feedback is generated by the remote computer system, and transmitted back to the portable computing device of the user.

Brief Description of the Drawings

Figure 1A illustrates a portable computing device;

Figure 1B illustrates a system embodiment of the invention;

Figure 2 is illustrates a set-up procedure for a user of calorie management software;

Figure 3 shows a menu screen on the display of a portable computer, from which a user selects a food item;

Figure 4 illustrates the interactions between a portable computing device and a remote computer over a communications network;

Figure 5 is a schematic showing communication between a portable computer and a remote computer system;

Figure 6 is a schematic showing a community of users interacting with a remote computer system;

Figure 7 is a schematic illustrating controlled user access to a data relating to a community of users;

Figure 8 shows a person breathing through an indirect calorimeter;

Figure 9 shows a cross-section of an indirect calorimeter suitable for use in embodiments of the present invention;

Figure 10 is a schematic of a weight control system including an indirect calorimeter;

Figure 11 is a schematic of a weight control system comprising a portable computer which interfaces with a desktop computer;

Figure 12 is a schematic of a weight control system in which an indirect calorimeter is located at a physician's office;

Figure 13 is a schematic of a system in which food data is received during a purchase transaction;

Figure 14 shows a wrist-mounted device used in embodiments of the present invention; and

Figure 15 shows a system embodiment using a wrist-mounted device.

Detailed Description of the Invention

Figure 1A shows a handheld microprocessor-based device 10, used in preferred embodiments of the present invention, having a user display 12 and a user information input in the form of data entry buttons 14. The device 10 is a portable computing device, preferably a personal digital assistant (PDA), but it can also be a wireless phone, an electronic book, a pager, other portable computer, or other portable electronic device having computational functionality. For convenience, portable computing device 10 will be hereinafter referred to as a PDA, though this is non-limiting as other portable computing devices can be used. The user may also input data into the PDA using a stylus, bar-code reader, finger motion detector, voice recognition method, track ball, or any other convenient input method. The PDA has a data transmission and reception means for transmitting data to (and receiving data from) a communications network, for example; a telephone modem, wireless modem, cable modem, network interface card, or other telecommunication transceiver. Preferably, the PDA is connected to the

communications network using a wireless connection, but cables, optical fibers, and other systems may also be used.

Figure 1B is a schematic of an improved diet control system. Portable computing device 10 is connected to a communications network 20. A remote computer system 30 is also connected to the communications network, so as to allow data to be transmitted between the computing device 10 and the remote computer system 30 over the communications network 20. The communications network provides a communications link between devices connected to the communications network. The portable computing device 10 also receives data from a physical activity sensor 16, and body weight scales 18. The portable computing device also can communicate with a computer 22, the computer 22 also being connected to the communications network 20.

The communications network 20 is preferably a public network adapted to receive data from the PDA, such as digital representations of data stored in the memory of PDA 10. The communications network 20 is preferably the Internet. The connection between the PDA 10 and the communications network 20 is preferably a wireless connection, such as a wireless Internet connection, however cables, phone lines, optical fibers and other communication links can also be used.

The remote computer system 30 is preferably a server system. The remote computer 30 is connected to the network 20, and is adapted to receive data from the PDA such as digital representations of data stored in the memory of PDA 10. The remote computer 30 has an application program for analyzing the user's caloric consumption, caloric expenditure, and net caloric balance, and for generating feedback (such as critical

messages, other advice, educational content, and the like) to the user, the messages and feedback relating to the user's progress toward a weight control goal. The remote computer 30 also has transmission circuitry for transmitting messages and feedback over the network 20 to the PDA 10. The messages and feedback act to motivate the user to make progress towards a weight control goal.

One system embodiment requires only PDA 10, communications network 20, scales 18, and remote computer system 30. This embodiment will be discussed first, and other systems including the activity sensor 16 and computer 22 are discussed later.

The PDA 10 has a software application program so as to assist the user to set and achieve weight goals. The program is adapted to receive user inputs related to user caloric intake and user caloric expenditure and to calculate user net caloric balance on a daily basis. For convenience, this program running on the PDA 10 will be called a calorie management program. The calorie management program comprises the functionality of diet logging software, and enables the user to record food items consumed. The PDA has a memory for storing user inputs related to caloric intake and caloric expenditure, and a transmission means for providing digital representations of the information stored in the memory.

Diet logging software suitable for adaptation for use in the present invention has been described in U.S. provisional application Serial No. 60/240,185, incorporated herein in its entirety by reference. Diet logging software is also described in U.S. Patent Nos. 5,704,350 and 4,891,756 to Williams, incorporated herein in their entirety by reference. A calorie management program running on the PDA allows the user to record food

intake, hence determining their caloric intake. Preferably, a database of food and drink items and associated nutritional data (such as caloric values) is stored on the PDA, and accessed by the calorie management software to correlate food identities with nutritional data. Alternatively, a database of food identities and associated nutritional data can also be located on the remote computer system 30. The remote database would preferably be more extensive, so as to allow expansion of the local database on the PDA as needed.

Before the start of the weight control program, the user completes a set-up procedure. Figure 2 illustrates an example set-up procedure which the user completes before starting a weight control program. Boxes 40-54 in Figure 2 represent functional steps provided by the calorie management software running on the PDA 10.

The user enters personal information (box 40), such as their name, alias, e-mail address, and a password. This information is used for communication with the user, and sharing data with other users, and other authorized persons such as health management workers. This step is only executed on the user's first use of the software, or if personal details change. Calorie management software on a single portable device such as 10 may support multiple users, for example through different password entry.

The user enters start parameters (box 42), such as starting date, initial weight, age, height, body fat percentage, lifestyle activity level, and frame size. If required, the software can present a comparison of the user's current weight and body mass index against accepted healthy ranges. The user also enters lifestyle information, such as occupation, physical activity levels, time at work, and time asleep. This information is used to estimate a value for activity energy expenditure AEE.

Preferably, the user determines their initial resting metabolic rate (RMR) using an indirect calorimeter, and enters this value into the calorie management software. The use of an indirect calorimeter in an improved weight control system is described in more detail later. If the user does not know their RMR, and an indirect calorimeter is not available, the Harris-Benedict equation is used to estimate the RMR of the user. This equation is described in U.S. Patent No. 5,839,901 to Karkanen, incorporated herein in its entirety by reference. However, it is important to note that the Harris-Benedict equation provides only an estimate of metabolic rate. (This estimate can be improved by determination of body fat content, for example using bioelectrical impedance analysis.) The software may display the daily values of REE, AEE (as determined from lifestyle activity data), and TEE to the user at this point.

The user then enters their goal or goals (box 44), such as a weight goal (weight loss, weight gain, or weight maintenance), fat loss, muscle building, blood pressure reduction, blood sugar control, and the like. In this specification, for convenience, we will consider the case of a user wishing to lose weight. In this case, the user enters weight loss goals, such as a total weight loss over a time period, or a desired weight loss rate (for example one pound per week).

The software determines a caloric intake level consistent with the weight loss goals (box 48). For weight loss, the caloric intake needs to be lower than TEE, i.e. the user's net caloric balance is negative and the user experiences a calorie deficit. The user's weight loss is related to the negative caloric balance (calorie deficit) via a parameter termed the calorie density. As discussed by Karkanen in U.S. Patent No. 5,839,901, a

calorie density of 3500 Cal/lb is conventionally used to predict weight loss from the calorie deficit. This implies that a calorie deficit of 3500 Cal/week is needed to lose one pound of body weight per week. The nutritional balance of consumed foods (the actual mix of carbohydrates, protein, and fat consumed, or planned to be consumed) recorded by the calorie management software can be used to determine a more accurate value for the calorie density. (The term calorie density is also used in the nutritional literature to refer to the calorie content per unit weight of food items. In this specification, the term calorie density is not used in this way, here calorie density refers to the relationship between caloric balance and body weight changes.) The software estimates an activity level and corresponding to AEE in calculating TEE, and hence the allowed caloric intake of the user.

Using conventional nutritional knowledge, a recommended nutritional balance is provided consistent with caloric intake goals (box 50). Dietary guidelines are well known to those skilled in the nutritional arts. The implementation of diet guidelines in preparing a balanced diet program within caloric limits, such as calculated using the Harris-Benedict equation, is discussed in U.S. Patent No. 5,639,471 to Chait et al., incorporated herein in its entirety by reference. The calorie management software can be used in meal planning. The user can enter dietary restrictions, for example allergens, and other foods to be avoided, so as to exclude foods from a planned diet program. Preferred foods can also be entered, for example a particular favored breakfast can be entered.

The user is offered the possibility of changing the activity level, which changes AEE and hence the allowed caloric intake (box 52). For example, a user might prefer to

exercise more and eat more, while still remaining within a planned calorie deficit. After such changes, allowed caloric intake calculations (box 48) and nutritional advice calculations (box 50) are repeated. The user then exits the set-up procedure, after confirming the accuracy of entered parameters (box 54), and can then start the weight control program.

During the weight control program, the user enters their diet log details into the PDA. As food items are entered into the calorie management software, the actual nutritional balance of consumed foods can be compared with target nutrition goals. Nutritional supplements or food alternatives are suggested if the diet log shows a nutritional imbalance. The calorie management software is adapted to receive user weight data at intervals, for example user weight as determined daily using scales 18. The calorie management software is also adapted to receive data relating to the user's resting metabolic rate, for example as determined using an indirect calorimeter. The use of an indirect calorimeter in an improved weight control system is described in more detail later.

Preferably, the user selects food items consumed from a menu system presented on the display 12 of the portable computing device 10, for example as described in U.S. Patent Nos. 5,704,350 and 4,891,756 to Williams et al., and in co-pending U.S. provisional application Serial No. 60/240,185. Figure 3 shows an example menu screen display from which the user can select food items from within groups.

If a particular meal is selected a number of times, it can be identified as a favorite by the software and presented to the user more prominently, for example at the top of a menu display.

The PDA is used to record and display caloric intake and caloric expenditure. The data may be presented as a running total in terms of caloric balance, or on a daily basis, indicating the days on which caloric balance goals were achieved.

The PDA can be used to record informal calorie management data, such as voice memos, images, notes, barcodes, or purchase information, and such informal data can be used to construct a full diet log at a later convenient time, using calorie management software running either on the PDA or on the remote computer system.

Preferably, the calorie management software running on PDA 10 receives data related to the physical activity level of the user. The user can enter the time, duration, and intensity of exercises or other activities into the calorie management software. Preferably, the PDA provides a menu of activities to the user and the user chooses an activity and enters a duration.

A button on the PDA 10, activity monitor 16, or other portable electronic device can be pressed at the beginning and end of an exercise to provide time and duration data. These time stamps can be used at a later time in creation of a detailed exercise log. Voice memos can also be recorded using an optical imaging sensor, for example to record an image to assist the user or other person to create an exercise log. The PDA may have an imaging functionality, or another device may be used. For example, if an image of an

exercise machine is recorded along with time of day and duration data, this will assist in the creation of a full exercise log at a later more convenient time.

The user preferably carries a physical activity monitor 16 which provides a signal related to physical activity, and preferably this is a body mounted pedometer comprising one or more accelerometers. Other types of activity monitors may be used, for example GPS-based monitors as described in U.S. patent applications Serial Nos. 6,148,262 and 6,002,982 to Fry. Physical activity monitors providing a signal correlated with one or more physiological parameters, such as heart rate, body temperature, respiration frequency, and the like can also be used in system embodiments.

Data can be transferred from the activity monitor 16 to the PDA 10 using a cable link, wireless methods (such as the Bluetooth protocol or an IR link), using the transfer of memory modules, or by the formation of a data transfer interface between monitor 16 and PDA 10. The calorie management software on PDA 10 receives any such activity-related data, and processes the data so as to provide an estimate of activity related data (AEE).

Heart rate and other physiological parameters can also be monitored to provide a signal related to physical activity. The PDA can receive data from other physiological monitors, for example scales, a body fat meter, a pulse rate meter, a body temperature sensor, and the like. The PDA can also be used to predict blood sugar levels of the person based on the glycemic index of the foods consumed and activities planned. Meals can be planned to avoid blood sugar levels outside of an acceptable range. The activity sensor 16 may possess additional functionality so as to act as a physiological monitor, physical location monitor, or environmental monitor.

At intervals, data is transmitted between the PDA 10 and remote computer system 30 over the communications network 20. Figure 4 illustrates an example interaction with the remote computer system. Boxes 60-70 represent functional steps.

The user initiates connection with the remote computer system (box 60), for example by logging in to a web-site provided by the remote computer system. Connections can also be initiated automatically at intervals.

The PDA 10 and remote computer system (server system 30) then enter a data synchronization step (box 62). Data recorded by the calorie management program, and stored in the memory of PDA 10, is transmitted to the remote computer system 30. This includes data related to caloric intake, the most recent weight of the user, physical activity data, and metabolic rate data (if available). A software program running on the remote computer system 30 (server software) receives the data and stores the newly receive data on a database, where it is accessible by the server software.

The received data and cumulative stored data are processed by the server software (box 66), so as to analyze the data in relation to user goals. The server software provides feedback to the user corresponding to the data analysis (box 68). Data analysis and feedback are discussed in more detail below.

The server software can present data to the user graphically. The server generates visual presentations of data, for example by dynamic generation of a website. The PDA is used to display the website to the user by the communications network. The website can be password protected, or otherwise only accessible to the user and other authorized people.

The user disconnects from the remote computer system (box 70) after data transfer steps are complete, and the user no longer wishes to view data representations generated by the server software. Feedback and critical messages generated by the server may be stored in the memory of the PDA 10, where they can be viewed later.

Figure 5 shows a further schematic of one example of how the user can communicate with the remote computer. Figure 5 shows an application program, running on remote computer system 30, in communication with a database 82, a source of dietary feedback 84, and a communications interface 86, preferably a web-site based interface. For example, the user's identity and password can be embedded in a URL provided to the server software. The user's PDA can communicate with the application program 80 via the web-site 86 over the communications network 20.

The user uses PDA 10 to connect to communication network 20. The user accesses a web site 86, providing a name and password which is passed to server program 80. Server program 80 recognizes the user. A synchronization step is performed, whereby user-related data stored on the PDA and in database 82 are compared, and in the case of inconsistencies, the most recent data is stored in both. For example, the user may change weight loss goals using the calorie management software on the PDA, the changes being recognized by the server software on connecting to the remote computer, and the changed goals stored in database 82. The server software requests data from PDA 10 over the communications network, and stores the data in appropriate fields of database 82. The server program 80 compares the recent data with the weight loss goals, and selects feedback from the available material provided by feedback source 84.

In other embodiments, the application software program on the remote computer (server software) may comprise calorie management functionality such as diet logging, and would be adapted to receive data from the PDA 10 such as the times and locations of meals. The user would then interact with the server software over the communications network, for example using the data entry mechanisms of the PDA to provide additional information needed to complete the diet log.

Data analysis by the server software and the provision of feedback to the user are now discussed in more detail. The application software on the remote computer system (server software) processes the data received from the user over the communications network, so as to determine appropriate feedback. The PDA is used to display audio-visual feedback received over the communications network for the purpose of providing dietary feedback to the user. For example, if the diet is progressing successfully towards a weight loss goals, the feedback would praise the user, and offer encouragement to the user to continue to succeed.

One or more parameters related to the degree of success of the program can be calculated by the server software (or by the calorie management software on the PDA), for example based on the calorie management data collected, current weight of the user, and program goals. The following non-limiting example illustrates how this may be achieved. If half the weight loss goal was achieved over the first half of the program, the parameter has the value zero, indicating that the progress is exactly on track. If no weight has been lost, the parameter has the value 100. If one quarter of the weight is lost, the parameter is 50. If the goal is met in half the required time, the parameter is (–100). The

feedback provided to the user is based on the value of this parameter. Different feedback is provided over different ranges of the value of this parameter. Other success parameters, or combination of parameters can be used. A novel diet success parameter is discussed in more detail later. The historical performance is also preferably included in the selection of appropriate feedback. For example, if exercise goals are not met during the first half of the program, the user is encouraged to exercise more by the provided feedback. However, if this feedback has no effect, as shown by subsequent data, the feedback is modified to provide stronger encouragement. For example, an appointment with a fitness consultant can be made automatically.

In the improved feedback mechanism described here, the nature of the feedback is determined by the status of the weight control program. A failure pattern can be recognized. For example, if weight has been gained despite a low recorded caloric intake, feedback may be provided to discourage the user from under-recording food consumption. If the diet log shows a prevalence of snacks recorded at a certain time of day, suggestions may be provided towards alternative activities instead of snacking, for example to drink water, go for a walk, or something similar. If certain times of days are recognized as a problem, the PDA may be used to schedule activities or other alternatives to snacking during problem times. An alarm may actually be provided to the user to discourage them from snacking at a time that is known to be problematic. If serious discrepancies from goals or acceptable healthy lifestyles are detected by the server software, a physician or other authorized person may be alerted. Activity levels, in terms of activity-related energy expenditure (AEE) or some activity-related parameter may be

compared with goals, and used in determining the nature of feedback or critical messages.

The planning and organizational functionalities of a conventional PDA can be effectively used in the improved diet control program described here, for example in planning meals and activities during the day.

Feedback can be in the form of video clips, animations, and the like. For example, the likeness of a doctor, fitness professional, or other person can be used to deliver a motivational or critical message to the user.

The feedback to the user can be adapted to the user's personality. For example, at the start of the program the user can indicate which style of feedback they would prefer, for example lecturing, aggressive, gentle, or other style. The style can be adjusted based on the effectiveness of previous feedback. If gentle feedback is not effective, then a more assertive style may be tried.

Feedback can be in the form of educational videos selected on the basis of the user's progress. For example, if recorded physical activity is lower than the set goals, a video of exercises can be provided.

Feedback can be sensed (viewed and/or listened to) by the user on any appropriate device having a connection to the communications network 20, such as an interactive television, web-TV, internet appliance, cell phone and the like. The remote computer may provide codes to the PDA, which can then be used to access feedback or other relevant content via such devices.

A feature of conventional diet programs is that meetings and communal weighings at certain physical locations can be used to exert peer pressure on the user. The expectations of the group influence the behavior of an individual user, and give the user more resolution to succeed than would be the case for a weight control program carried out in isolation. This effect is known to be considerable, and in part justifies the fees charged by conventional diet businesses.

Figure 6 shows remote computer system 30 used in the creation of a community of users (represented by portable computing devices 10, 90, 92) interconnected by the communications network 20. In practice, the community may be considerably larger than three users. The results for an individual user can be presented to the rest of the group using an alias, or partial identification. Discussion groups can be set up.

Figure 7 shows a schematic of how an individual user receives community data using the communications link to the remote server. The user, using PDA 10, connects to communications network 20, preferably the Internet, and exchanges data with server software 80 through website-based interface 86. The user can access all of the data stored in database 82, which is associated with the user, and a limited sub-set of data fields from other databases related to other community users. For example, a diet success parameter and an alias may be accessed. The user may view a graphical presentation of the other users' progress towards weight loss goals, which can provide additional encouragement. For example, a user may observe that relative success falls for most users over a holiday period and then picks up, encouraging the user to continue in a program after a holiday period which has involved excessive calorie intake.

The community can be divided into groups for the purpose of encouraging competition between groups. For example, the community can be divided along lines such as geographical areas, college alumni, etc. For example, rivalry between alumni of historically competing universities, or between supporters of sports teams, can be used to generate additional motivation between groups of users. The group can also be divided by weight divisions, target weight loss, gender, age, state, or some other demographic factor. Users with common health concerns can also be grouped together. Validation at the end of a weight loss program is performed if substantial rewards are given for best performance. For example, users would report to a given location for an end of program weighing.

Studies have shown that a social support network can also be useful in lowering the injury rate during a physical activity program. Hence, the community of users accessible by the Internet will help encourage a healthy activity program.

Recently, James R. Mault M.D. et al. invented an improved indirect calorimeter, well suited for use in an improved weight or health management system. This device, sometimes known as the Gas Exchange Monitor (GEM), is preferably used in the improved weight and health control program described here. In a preferred embodiment, the GEM is a handheld indirect calorimeter which determines the user's metabolic rate by analyzing the user's inhalations and exhalations to determine oxygen consumption from the difference between exhaled and inhaled flow volumes of oxygen. The GEM may also be supported by straps around the user's body (for example, around the head), by a helmet, or by another support mechanism relative to the user's body. The improved

indirect calorimeter is best described in U.S. application Serial No. 09/630,398, which is incorporated herein in its entirety by reference. A brief description of the calorimeter follows.

Referring to Figures 8 and 9, the calorimeter according to U.S. application Serial No. 09/630,398 is generally shown at 100. The calorimeter 100 includes a body 102 and a respiratory connector, such as mask 104, extending from the body 102. In use, the body 102 is grasped in the hand of a user and the mask 104 is brought into contact with the user's face so as to surround their mouth and nose, as best shown in Figure 8. Optional straps 105 are also shown in Figure 8. With the mask 104 in contact with their face, the user breathes normally through the calorimeter 100 for a period of time. The calorimeter 100 measures a variety of factors and calculates one or more respiratory parameters, such as oxygen consumption and metabolic rate. A power button 106 is located on the top side of the calorimeter 10 and allows the user to control the calorimeter's functions. A display screen is disposed behind lens 108 on the side of the calorimeter body 102 opposite the mask 104. Test results are displayed on the screen following a test. Other respiratory connectors can be used, for example a mouthpiece.

Figure 9 shows a vertical cross section of the calorimeter 100. The flow path for respiration gases through the calorimeter 100 is illustrated by arrows A-H. In use, when a user exhales, their exhalation passes through the mask 104, through the calorimeter 100, and out to ambient air. Upon inhalation, ambient air is drawn into and through the calorimeter and through the respiratory connector to the user.

Exhaled air passes through inlet conduit 110, and enters connected concentric chamber 112. Excess moisture in a user's exhalations tends to drop out of the exhalation flow and fall to the lower end of the concentric chamber 114. Concentric chamber 112 serves to introduce the respiration gases to the flow path 116 from all radial directions as evenly as possible. Exhaled air flows downwardly through a flow path 116 formed by the inside surface of the flow tube 118. Exhaled air enters outlet flow passage 120, via concentric chamber 122, and passes through the grill 124 to ambient air.

Flow rates through the flow path 116 are determined using a pair of ultrasonic transducers 126 and 128. An oxygen sensor 130, in contact with respiratory gas flow through opening 132, is used to measure the partial pressure of oxygen in the gas flow. Integration of oxygen concentration and flow rate allows inhaled oxygen volume and exhaled oxygen volume to be determined. The metabolic rate of the user is determined from the net oxygen consumption; the difference between inhaled and exhaled oxygen volumes. Metabolic rate is determined using either a measured or assumed respiratory quotient (the ratio of oxygen consumption to carbon dioxide production). For a user at rest, the RMR (resting metabolic rate) is determined. The RMR value is shown on display 109, behind window 108.

Preferably, the indirect calorimeter used in embodiments of the present invention comprises a respiratory connector such as a mask or mouthpiece, so as to pass respiration gases as the subject breathes; a flow pathway between the respiratory connector and a source and sink of respiratory gases (such as the atmosphere) which receives and passes the respiration gases; a flow meter configured to generate electrical signals as a function

of the instantaneous flow of respiration gases passing through the flow pathway, such as an ultrasonic flow meter; and a component gas concentration sensor, such as a fluorescent oxygen sensor, which generates electrical signals as a function of the instantaneous fraction of gases such as oxygen and/or carbon dioxide in the respiration gases they pass through the flow pathway, such as the indirect calorimeter described above. The user's resting metabolism can be measured at repeated time intervals using the indirect calorimeter. The user breathes a multiple of inhalations and exhalations through the indirect calorimeter, so that the inhaled air and exhaled gas passes through the indirect calorimeter, the inhaled air volume and the exhaled flow volume are integrated with the instantaneous concentration of oxygen, and so the exhaled, inhaled, and consumed oxygen are determined. The component gas concentration sensor can be omitted if the molecular mass of respired gases is determined using an ultrasound method, in which case oxygen volumes consumed can be determined using ultrasound without a component gas sensor. Other indirect calorimeters can be used in embodiments of the present invention, for example such as described in U.S. Patent Nos. 4,917,104; 5,038,792; 5,178,155; 5,179,958; 5,836,300, and 6,135,107 all to Mault, which are incorporated herein in their entirety by reference. The indirect calorimeter can also be a module which interfaces with the PDA. The display, buttons, and process capabilities of the PDA are used to operate the module, display instructions for use of the indirect calorimeter, initiate tests, and record data.

Figure 10 shows an improved weight loss program in which an indirect calorimeter is used to monitor the metabolic rate of the user at intervals. PDA 10 receives

data at intervals from the indirect calorimeter 100, related to the metabolic rate of the user. The data can be transferred by a wired or wireless connection, by manual input, or by exchange of memory modules. PDA 10 receives a signal related to physical activity related data from activity sensor 16. The user weighs themselves using scales 18 and enters or otherwise communicates the data to the PDA 10, for example on a daily basis. The PDA is in communication with a communications network 20 allowing data to be exchanged with remote computer system 30, as discussed in detail above.

In the preferred embodiment, the PDA is provided with calorie management software as described above. Before the start of the weight control program, the metabolic rate of the user is measured using the indirect calorimeter, preferably the gas exchange monitor invented by James R. Mault, M.D. et al. The user start weight is also entered. Goals are entered, for example a planned weight loss rate. Using RMR and estimated activity levels, a caloric expenditure is advised. A suggested level of activity related energy expenditure is provided, and converted to a suggested exercise program, for example exercises suggested each day or every few days.

Weight loss programs often fail due to the user's fall in resting metabolic rate in response to diet. The indirect calorimeter invented by Mault et al. allows a solution to this problem to be provided. The user's metabolic rate is measured at intervals during the diet program. Experiments have shown that metabolic rate often falls significantly after the onset of a diet. Hence, even if caloric intake is decreased, total energy expenditure may also fall, leading to a failure of the weight control program despite good faith efforts

of the user. Hence, measurement of resting metabolic rate at intervals is beneficial in a weight control program.

It should be noted that the response of resting metabolic rate to diet is unpredictable, so that it is not accurate to use the Harris-Benedict equation (or similar equations based on height, weight, age, and gender) to estimate RMR after the onset of a diet. In conventional weight loss schemes, resting metabolic rate is estimated using the Harris-Benedict equation, which may indicate a fall in resting metabolic rate corresponding to a fall in weight of the person. However, weight loss may be related to water loss, fat loss, or some other change which is not correlated with metabolic rate changes.

Hence, in the improved weight loss program described here, resting metabolic rate is measured at intervals, for example every day during the first week of a weight loss program. Data is transmitted to the server software over the communications link, which processes the data so as to determine appropriate feedback. If collected RMR data shows a significant fall during the time of the weight control program (from historical pre-program values (or the starting value) to the current value of RMR), it is can be beneficial to increase the activity of the person. The server software may provide suggestions of how to improve activity related energy expenditure (AEE) to the user over the communications network. Feedback may advise a further reduction in caloric intake. However, both increased activity and reduced caloric intake can initially lead to a further reduction in resting metabolic rate. Hence, it is important to monitor RMR closely, for example on a daily basis, after a change in dietary or activity parameters. It may be

necessary to reduce the weight loss goals of the diet program to avoid failure and demoralization of the user. Preferably, a combination of increased activity and reduced caloric intake is used to restore the calorie deficit to a required value to achieve the set weight loss goals.

Preferably, activity is used to increase TEE if RMR falls. Activity can help restore REE to previous levels, or even higher. If muscle mass is restored or increased, metabolic rate may be returned to the original value or increased.

The calorie management software on the PDA calculates calorie balance using the latest measurement of resting metabolic rate of the user. Data synchronization with the server software, over the communications network, is used to provide the latest calorie management data to the server software.

The application program on the remote computer (server software) receives the calorie management data from the PDA at intervals, the data comprising caloric intake data, activity data, body weight, and resting metabolic rate of the user. The server software analyzes the data in relation to the probability of the user meeting weight goals, and provides feedback to the user over the communications network. For example, if the resting metabolic rate of the user falls in response to the weight control program, the server software will provide feedback to assist the user meet a weight goal in view of the changing RMR. No conventional weight control system allows this. For example, the caloric intake allowance may be decreased, activity levels increased, weight goals may be modified, or some combination suggested. The user may enter an interactive dialog with the server software, or a human advisor, over the communications link, so as to establish

new diet parameters. A database of previous RMR responses to changed diet regimens may be maintained on the remote computer system, allowing the server software to act as an expert system. For example, it may be determined that the resting metabolic rate of specific demographic groups is likely to respond positively to exercise, so a user within those groups would be encouraged to exercise more. Certain compounds are believed to increase metabolic rate, such as phosphates (as discussed in U.S. Patent No. 6,113,949 to Brink), and these may also be recommended in certain circumstances. Other compounds may also be recommended, such as appetite suppressants, diet additives to impede fat absorption, stimulants, and the like. The user's response to known and suspected metabolism enhancers and other dietary supplements can be quantified using the GEM, and the results used in developing a diet program. Medical supervision can be provided as necessary. Advantages of the server software system described here include the ability of the weight control business administering the program to monitor the effect of given advice, continually update advice algorithms based on effectiveness, and the ability to alert health professionals if necessary.

The signal provided by physical activity monitor 16, exercise machine data, or physical activities having defined parameters can be correlated with total energy expenditure (TEE) using an indirect calorimeter, and hence with activity related energy expenditure (AEE = TEE – REE). This is described more fully in co-pending application 09/684,440, which is incorporated herein in its entirety by reference. For example, a version of the Gas Exchange Monitor equipped with a face mask is worn during an activity. AEE is determined using the indirect calorimeter. For example, after REE of the

user is determined, the indirect calorimeter is switched into "activity mode" in which the increase in energy expenditure due to activity (AEE) is displayed. AEE is then correlated with one or more exercise parameters (such as treadmill speed, treadmill gradient, walking speed, running speed, step rate during e.g. running on the spot or other exercises, specific exercise repetitions, exercise intensity, and the like), one or more activity monitor parameters (such as pedometer signal, accelerometer signal, exercise machine data, exercise repetition monitor, signals from multiple devices, and the like), or with one or more physiological parameters (such as pulse rate, body temperature, surface (skin) temperature, skin conductivity, respiration noise level, respiration frequency, and the like). The correlation or correlations determined are then used to determine AEE during an activity from one or more measured parameters as discussed above. AEE can also be determined for general work or recreational activities, such as typing, computer work, driving, or other user activities.

Figure 11 shows PDA 10 synchronized at intervals with personal computing device 22. The PDA is docked, wired, interfaced, or otherwise in communication with the computer 22, so that data can be transmitted between the PDA 10 and the computer 22. Computer 22 is connected to communications network 20, and is used to display audio-visual feedback from content provider (or feedback provider) 140, the content, feedback, or other critical messages being provided to the user based on the user's progress towards health goals, such as weight loss.

The computer 22 is preferably a conventional desktop personal computer, but it can also be an entertainment device, a web TV, Internet appliance, interactive TV, or

some other electronic device, preferably having display capabilities and a communications link to communications network 20. Calorie management software operable on computer 22 may be used to create the diet log for the user. The PDA 10 can be used to capture data such as voice records, times of meals, times of exercise, exercise nature, exercise intensity, images of food, barcodes, product identification using optical character recognition, purchase information, menu descriptions, and the like. The improved display capabilities and data entry mechanisms of the computer 22 facilitate creation of the diet log and collation of calorie management data. An activity log can also be created on computer 22. Calorie management software running on the PDA is used to record the food eaten and activities; for example, this can be achieved by recording the times of meals and activities along with possibly an accompanying voice memo or image, and the times and accompanying data are then be used as memory prompts when creating a full diet log on the computer 22 at a later convenient time.

Data is transferred to the remote computer system 30 at intervals. Data is then synchronized between the computer 22, the remote computer system 30, and PDA 10. Calorie management data, is sent to the server, and revised goals, programs, activities or other feedback data are transmitted from the remote computer system 30 to the computer 22 and PDA 10. The synchronization of data between the computer 22, PDA 10, and the remote computer system 30 is an important aspect of this invention. The PDA 10 is synchronized with the computer 22, so that revised goals are shown on software running on the PDA, for example to provide reminders to exercise, reminders of goals, and meal plans.

A conventional diet measures success in terms of weight loss in pounds. However, the nature of the weight loss is important to the long-term success of the diet. For example, if weight loss is achieved through water loss, the water is replaced quickly and no long term weight loss is achieved. If muscle tissue is lost, the situation is even worse as this causes the user's resting metabolic rate to fall over the long term, and if the user returns to pre-diet caloric intake, the weight will be regained and then additional weight is likely to be added. This is an extremely unsatisfactory situation which commonly occurs with conventional weight loss programs.

Hence, an improved diet success parameter M may be defined which takes into account the benefits of increased metabolic rate, fat loss, fitness increase, cardiovascular health improvement, stamina improvement, strength improvement and the like. For example M can be defined as:

$$M = aW + bR + cF$$

where W = weight loss, R = resting metabolic rate increase, F = body fat mass loss, and a, b, and c are numeric parameters preferably chosen to put M in a convenient numeric range such as 0-100.

A diet can be a success even if no weight is lost, for example if body fat is lost and the user's metabolic rate increases. In a conventional diet program, a lack of weight loss is considered a failure. However, by increasing RMR, a person will then subsequently lose weight slowly with a caloric intake equal to the level needed to maintain weight at the previous RMR.

RMR is preferably measured using an indirect calorimeter, such as the Gas Exchange Monitor discussed earlier. An indirect calorimeter is preferably used in the weight control systems described here to assist in determination of caloric balance. The indirect calorimeter data can then also be used in the determination of an improved diet success parameter.

Body fat percentage can be determined using bioimpedance, for example using scales available commercially from various sources, such as the Tanita Corporation of Japan. Body fat percentage can also be determined using an indirect calorimeter. The RMR of the person is related to their muscle mass, since the fat cells do not significantly contribute to the metabolic rate of the person. Hence, body fat percentage can be calculated using the user's height, weight, and the user's measured RMR. Hence, the Gas Exchange Monitor can be used to track the success of a diet, as well as used to modify the weight loss goals of a diet. If needed, the diet success parameter is calculated by the calorie management software resident on the PDA.

An indirect calorimeter may be provided at a doctor's office, weight loss business office, gym, public location such as a drugstore, and the like.

Figure 12 shows a system configuration suitable for use in situations in which an indirect calorimeter is provided at a location such as a doctor's office. Figure 12 shows an indirect calorimeter 100 providing data to physician's computer 150. A physiological monitor 152 is also connected to physician's computer 150. The user's PDA 10, user's personal computer 22, remote computer system 30, and physician's computer 150 are connected to communications network 20.

Data from the indirect calorimeter 100 is communicated to a computer 152 located at the doctor's office (the physician's computer). After review and analysis, the data is transmitted via the communications network 20 to the remote computer 30. Synchronization of the PDA 10 with the server 30 over the communications network 20 allows the RMR data to be updated on software running on the PDA. Other medical information can be entered into the physician's computer 150, sent to a database on remote computer system 30, and synchronized with the PDA. This system can also be used for an improved method of conveying the results of medical tests to a patient. Additional physiological data obtained out at the doctor's office, such as cardiovascular testing, can be transferred to the database on remote computer system 30.

The PDA can be used in the purchase of goods, such as over a communications network or at a physical location such as a store. For example, the PDA can enable the purchase of goods or services via the authorized debiting of a bank account. The PDA display may provide an image of the user for identification, and the user could provide an electronic signature, identification number, or sign on an area of the display of the PDA. If the PDA is used to purchase food items, the food identity can then be stored in the memory of the PDA, and accessed by calorie management software for the purpose of creating a diet log.

Figure 13 shows a purchase system in which PDA 10 communicates with check out system 162. The PDA 10, check out system 162, remote computer system 30, and bank computer 160 are connected to communications network 20, preferably the Internet. At the time of purchase, a communication is sent from PDA 10 to bank 160, authorizing

the debit of an account associated with the user to pay for the purchased goods. The check out system 162 transmits the identities of items purchased to the PDA, and/or to the remote computer system 30. The identities of food items are correlated with nutritional data, for example using a database on remote computer system 30, for assistance with the creation of a diet log.

Food items can also be purchased by conventional methods, and the nutrition content of purchased goods transmitted to the PDA via a wireless method, IR beam, cable, optical character recognition, or barcode scanning. The identification of the purchased items can be stored on the PDA, or on a remote database, for example on the remote computer system 30.

Meals supplied by a vending machine may also be stored on the PDA if the PDA was used in the purchase process, for example through initiation of food dispensing and an account debit. The identity of the chosen item is then subsequently used in creating a diet log.

The PDA may also have a barcode scanner adapted to receive data from scanned packages. The PDA may also be equipped with a wireless receiver to receive data from a food vending machine or a checkout machine at a grocery store.

In a further embodiment, the user is provided with a wrist mounted device, having a time display and buttons adapted to record the times of meals and activities. These time stamps act as a memory prompt at a later time when the user is compiling a detailed diet log and activity log.

Figure 14 shows a schematic of a wrist-mounted device for inclusion into an improved weight control or health management program. The wrist-mounted device, shown generally at 170, has a generally rounded housing 172 in the style of a wristwatch, supported on the user's wrist by strap 174. A microphone 176 is contained within the housing 172, and provides a method of storing voice records on a memory contained within the housing 172. The wrist-mounted device has a mode button 178, a food flag button 180, a record/transmit button pair 182 and 184, an IR downlink port 186, a mode display 188, a time display 190, an activity display (or exercise display) 192, and a food display 194. A heart rate sensor (not shown) is provided on rear of the housing, so as to contact the wrist of the user and provide a signal related to heart rate of the user.

The mode button 178 is used to switch between operating modes, which might include time display only, pulse rate, time from the start of an exercise, food display, activity level display, combinations of the above, and other information.

The food flag button 180 is pressed when food is eaten. The time stamp (the time at which the button was pressed) is used in creating a diet log at a later date. The time stamp data may be supplemented by recorded voice memos using the microphone. The recorded memos preferably have a time added, for assisting with diet log creation.

IR downlink port 186 is used for data transfer to another device. This comprises an IR emitter and IR detector, so as to communicate with other devices using an IR beam. The transmit/record button pair (182 and 184) are pressed to initiate IR communication using port 186. Other wireless communications methods such as the Bluetooth protocol

can also be used for data transfer. Cable links or memory module transfers can also be used.

In the preferred embodiment, photo-plethysmography is used to determine the heart rate of the user. An IR source is reflected from the wrist and used to monitor the heart rate. Other techniques known in the art may be used, for example pneumatic plethysmography, in which variations in pressure are monitored, impedance cardiography, and phonocardiography.

Other physiological monitors which may be incorporated into the wrist-mounted SAM include a blood glucose sensor, a temperature sensor, an accelerometer, and the like. An optical imaging device can be provided for recording digital images of foods consumed.

Figure 15 shows wrist-mounted device 170 adapted to transfer data to computer 22. Computer 22 is connected through communications network 20 to remote computer system 30.

In the improved weight control system, time stamps and voice memos recorded on device 170 are downloaded to computing device 22, preferably using a cable connection or IR link, and calorie management software running on computer 22 is used to create a diet and exercise log using the data transferred from device 170 as memory prompts. A PDA can be used in place or in addition to computer 22 for creating diet and exercise logs. Data communication with remote computer system 30 over network 20, for assistance in achieving weight control goals, is as discussed above.

In a business model, a health management company provides a diet logging device, or diet logging software adapted to run on a device owned by the user. Preferably, the user has a personal digital assistant (PDA) with diet logging software installed. Exercise log software can also be provided so to allow the user to record time durations and intensity of exercises performed.

A health management company, such as a weight loss company, supplies the user with diet logging software, exercise log software, and access to an Internet site. Preferably, the user also has access to an indirect calorimeter, allowing the user to measure their resting metabolic rate at intervals. The health management company may sell the indirect calorimeter to the user; alternatively, it may be provided as part of a subscription towards a complete weight management program. The health management company may also sell disposables for use in the indirect calorimeter.

The health management business also provides the remote computer 30 and a website accessible through a communications network. The health management business provides a software program running on the remote computer 30 adapted to receive diet log and exercise log data relating to the user, and further adapted to provide feedback to the user. Preferably, employees of the health management business can access data relating to a user for review and further feedback. The feedback to the user can be provided in a largely automated process involving a computer expert system. Preferably, the feedback is made more user friendly by generating for example an animated human face accompanying the audio advice. Appropriate video clips may also be selected to provide detailed feedback. Such computationally intense software is presently better

suited for running on the remote computer than on a handheld device, however in the future it may be possible to generate animations on the handheld device responsive to wireless communications from the remote computer. In relating to website feedback, the software receives caloric intake, activity related data, and weight data of the user. The software generates a graph of caloric balance, weight, and other health related parameters against time. For example, a running caloric balance may be provided to indicate the user's success on a diet program. Alternatively, a day-by-day feedback may be provided in which days with a positive caloric balance are indicated as good, for example using colors or money symbols or weather-related symbols, whereas days with a negative caloric balance are shown as bad using appropriate symbols.

Feedback is related to the success of the diet program as shown by the user's data. If caloric intake is too high, the feedback may suggest meals which are appropriate to meet goals, for example using a database of meals located on server 30. If the caloric intake is within the goals of the program, but weight loss has not been achieved, an activity schedule is suggested so as to help the user achieve their weight loss goals. This may be indicative of a fall in metabolic rate due to the effects of a diet program on the user's physiology, and if an indirect calorimeter is available, the feedback would prompt the user to measure their metabolic rate at a time in the near future. If caloric intake is apparently lower than the goals of the program, the weight gain or no weight loss is recorded, the feedback may again suggest measuring metabolic rate but may also provide feedback on sources of recording error. For example, the user may be under recording their diet, which is a particular problem if a large number of meals are eaten out. The

health management business may sell prepackaged meals, or may be affiliated with a company that supplies such meals, and the feedback may suggest the user purchase these meals in order to record a more accurate diet log. If caloric intake is lower than the goals of the program, and excessive weight loss has been achieved, the user will be provided with feedback on health risks of an accelerated weight loss program.

Using the communications network, the user can request information from the server system 30 regarding metabolic rate, diet, nutrition theory, and physiology. This information can be provided as text, audio, or combined audio/visual presentations supplied from the remote computer system 30 and displayed on the PDA.

Feedback may also be provided using another device accessible by the user, for example an entertainment device such as an interactive TV, web TV, Internet appliance, and the remote computer system will then provide the feedback on the other device. Medical information can also be provided by the feedback mechanism. The user's physician or other authorized medical professional may also monitor the data recorded in the diet log and exercise log. The weight control business may supply foods, advice, diet plans, exercise programs, or services provided by affiliated companies. For example, recipe advice may be combined with automated online ordering of groceries from an online retailer of food, allowing the user to plan and order foods for the next week's menu. The software running on the remote server also preferably performs a nutritional analysis of the diet log record relating to the user, and recommends supplements of minerals, vitamins, proteins, amino acids, and other nutritional elements, for example in affiliation with nutritional supplement retailers.

The software program on server 30 may also provide culturally sensitive or allergy related feedback, for example recommending foods consistent with the user's chosen lifestyle. For example, vegetarian meals, peanut free meals, or other suitable diet plans may be provided. The website may also be personalized in terms of the user's interests, for example providing up-to-date stock market reports or sports reports to give the user additional reason to check the site daily.

Software distribution mechanisms include provision of the user with a PDA having preinstalled software, web download to a computing device already owned by the user, distribution of CD-ROMs for installation on a PC and transfer of software to a PDA, memory stick or other memory module distribution, or other suitable mechanism.

A weight control businesses may provide vending machines for prepackaged meals. The PDA 10 can be used to order the prepackaged meals, providing an authorization code, and billing the cost of the meal to the program.

A fitness center allows a suitable source of interaction with the user. In the preferred embodiment, the fitness center provides access to an indirect calorimeter, such as the gas exchange monitor. The user pays a subscription to the fitness center for use of the facilities, and this subscription can also include use of the indirect calorimeter at intervals. Alternatively, the fitness center or a supplier can sell disposable elements for use in the indirect calorimeter.

An exercise program is devised to improve the fitness, health and perhaps reduce the weight of the user. A fitness parameter can be defined and tested over time. For example, the use of heart rate response during an exercise routine can be parameterized

using one or more variable parameters, and these may be recorded as an indication of the fitness level of the user. The fitness level data is stored on the user's PDA, or recorded in a computer system provided by the fitness center.

The indirect calorimeter can be connected to the fitness center computer, so as to allow metabolic rate data to be stored. The user preferably logs into the computer system, so data relating to the user is stored in a local database. A fitness advisor at the gym can help set weight and fitness goals.

Health related parameters which can be tracked include body fat percentage, metabolic rate, pulse rate and its response to exercise, the number of exercise repetitions achievable by the user, or some combination of the above or other parameters.

For a different exercise program, an indirect calorimeter adapted to be worn by the user during the exercise can be used to calibrate the energy expenditure of the user during the course of the exercise. Equations may be defined, which may be individualized for the user, which give caloric expenditure in terms of duration and intensity of a particular exercise.

Diet planning can be achieved using a computer expert system or using the advice of a nutritionist affiliated with the fitness center.

An activity goal can be used to set the contents of the program. For example, if the user is planning to run a marathon at some time in the future, a goal of improved cardiovascular efficiency can be defined and progress towards that goal tracked over time.

A respiratory monitor can also be used during exercise to detect respiratory components indicative of fat metabolism, such as ketones, in particular acetone. Acetone production in the breath can be used as an indication of the onset of fat burning, and can be used in a weight control program to improve the efficiency of fat burning in a weight loss program.

The user accesses the fitness center website to monitor their progress towards a goal. The PDA or other hand-held device is carried by the user, and provides information so as to assist the user to reach any set goal, and provides advice on nutrition and exercise programs which may have previously been set. The conventional organizational functionalities of the PDA can also be used to schedule appointments with fitness trainers and to schedule the start time and duration of planned exercises. The user can access the website provided by the fitness center to monitor progress towards their goals. A fitness trainer can be provided with a computing device such as a PDA. The device preferably runs software which can monitor the progress of several clients towards their goals. Software on the computing device allows the fitness trainer to set up identities for a number of users. The set up information might include name of user, start weight, goal, and any medical information relevant to the achievement of the goal. As the user's program progresses, data is synchronized to the fitness trainer's PDA, allowing the fitness trainer to monitor the progress of the various clients towards their goal.

While the invention has been described with reference to a number of embodiments, it will be understood to those skilled in the arts that the invention is not

limited thereto. The scope of the invention is to be determined by the following claims and their legal equivalents.

I claim:

1. A system for controlling the weight of a user, comprising:

a handheld microprocessor-based device having:

a user display,

a user information input,

an application program adapted to receive user inputs related to user caloric intake and user caloric expenditure and to calculate user net caloric balance on a daily basis,

a memory for storing user inputs related to caloric intake and caloric expenditure, and

transmission means for providing digital representations of the information stored in said memory,

a public network adapted to receive said digital representations from said handheld device; and

a remote computer connected to said public network and adapted to receive said digital representations, said remote computer including

an application program for analyzing the user's caloric consumption, caloric expenditure and net caloric balance, and generating a critical message to the user relating to the user's progress toward a weight control goal, and

transmission circuitry for transmitting the message over the public network to said handheld device;

whereby the user is motivated to make progress towards a weight control goal.

2. The system for controlling the weight of a user of claim 1, wherein the said application program forming part of the handheld microprocessor-based device, is further adapted to receive user inputs relating to user weight on a periodic basis.

3. The system for controlling the weight of a user of claim 1, wherein the user inputs related to user caloric expenditure include measurements of user metabolism on a periodic basis.

4. The system for controlling the weight of a user of claim 3, wherein said measurements of user metabolism at time intervals are made using a handheld indirect calorimeter which analyzes the user's inhalations and exhalations to determine inhaled and exhaled flow volumes and exhaled oxygen concentration.

5. A system for assisting a person to reach a weight goal, the system comprising:

a portable computing device;

calorie management software on the portable computing device, operable to receive calorie management data related to the person, the calorie management data comprising weight goal data, caloric intake data, and activity level data;

a communications link between the portable computing device and a remote computer system; and

application software on the remote computer system, operable to receive calorie management data from the portable computing device over the communications link, to process the calorie management data, to determine feedback based on the processed data, and to transmit feedback to the portable computing device over the communications link;

whereby the person receives feedback helpful in meeting a weight loss goal.

6. The system of claim 5, wherein the calorie management software is further operable to calculate the caloric balance for the person.

7. The system of claim 6, wherein the processing of the calorie management data comprises a comparison of the caloric balance of the person with the weight goal.

8. The system of claim 5, wherein the calorie management data further comprises a resting metabolic rate for the person.

9. The system of claim 8, wherein the resting metabolic rate is determined using a hand-held indirect calorimeter.

10. The system of claim 8, wherein the processing of the calorie management data comprises a comparison of the current resting metabolic rate with an historical metabolic rate.

11. A method of controlling a user's weight, comprising:

measuring the user's weight at intervals;

measuring the user's metabolism at intervals;

generating signals representative of the user's physical activities;

entering signals representative of the measured weight, the measured metabolism, and the activity into a handheld microprocessor-based device having:

a user display,

a user information input,

an application program adapted to receive user inputs related to user weight, user metabolism, user activity, user caloric intake and to calculate user net caloric balance on a regular basis,

a memory for storing user inputs, and

transmission means for providing digital representations of the information stored in the memory;

providing information stored in the memory to a public network;

receiving the stored information from a public network on a remote computer connected to said public network, said remote computer including an application program for analyzing the user's caloric consumption, caloric expenditure and net caloric balance and generating a critical message to the user relating to the user's progress toward a weight control goal;

transmitting said critical message to said handheld microprocessor-based device over said public network; and

displaying the critical message to the user on said handheld microprocessor-based device to motivate the user toward progress toward a weight control goal.

12. A method of controlling the progress of a user toward a weight control goal, comprising:

measuring the metabolism of a user at repeated time intervals by use of an indirect calorimeter through which the user breathes a multiple of inhalations and exhalations, so that the inhaled air and exhaled gas pass through the indirect calorimeter and the inhaled air volume is measured and the exhaled flow volume is integrated with the instantaneous concentration of oxygen to measure the exhaled oxygen;

weighing the user at repeated time intervals;

measuring the bodily activity of the user;

entering signals representative of the user's measured weight, metabolism, bodily activity and food and drink intake into a handheld, microprocessor-based device having:

a display screen,

user inputs,

a memory,

a database of caloric values of food and drink, and

a telecommunication transceiver;

transmitting information stored in the memory of the handheld microprocessor-based device over a public network to a remote computer;

calculating a daily caloric balance for the user;

generating a critical message for the user related to the user's progress toward a weight control goal at the remote computer based on information including the daily caloric balance of the user; and

transmitting the critical message over the public network to the handheld microprocessor-based device for display to the user.

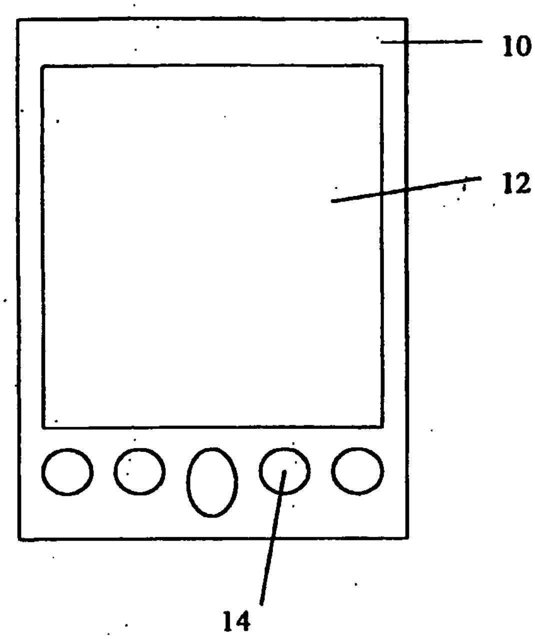


Figure 1A

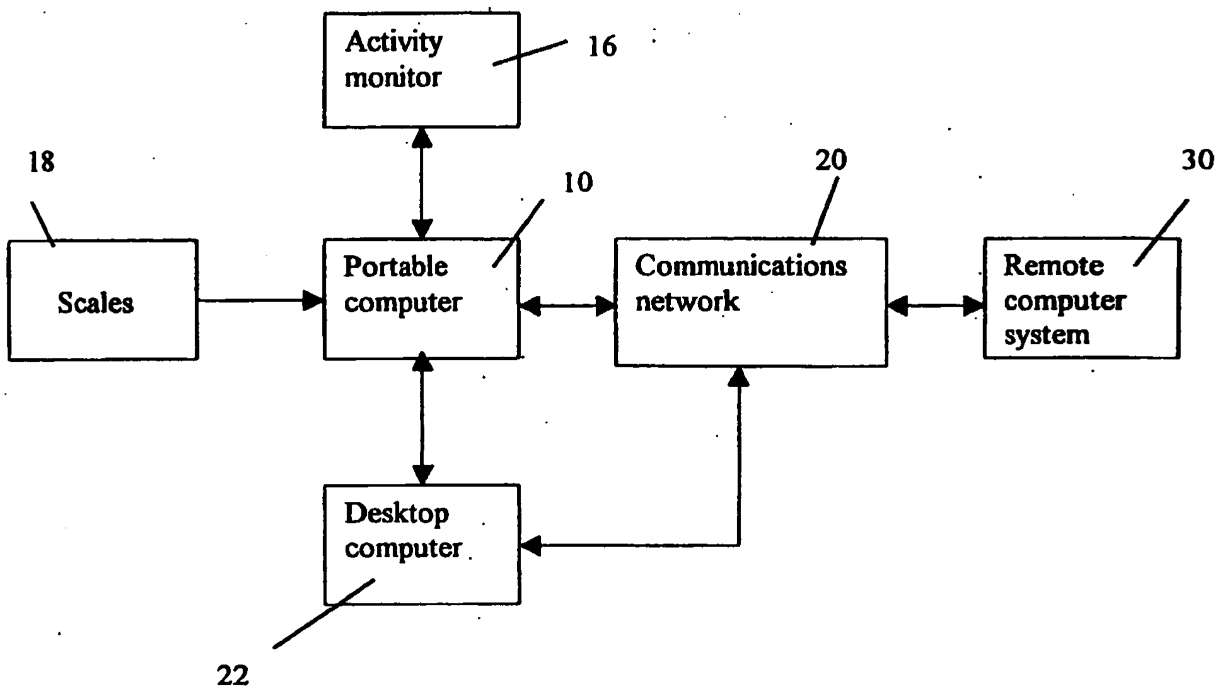

Activity monitor
16
18
10
20
30
Scales
Portable computer
Communications network
Remote computer system
Desktop computer
22

Figure 1B

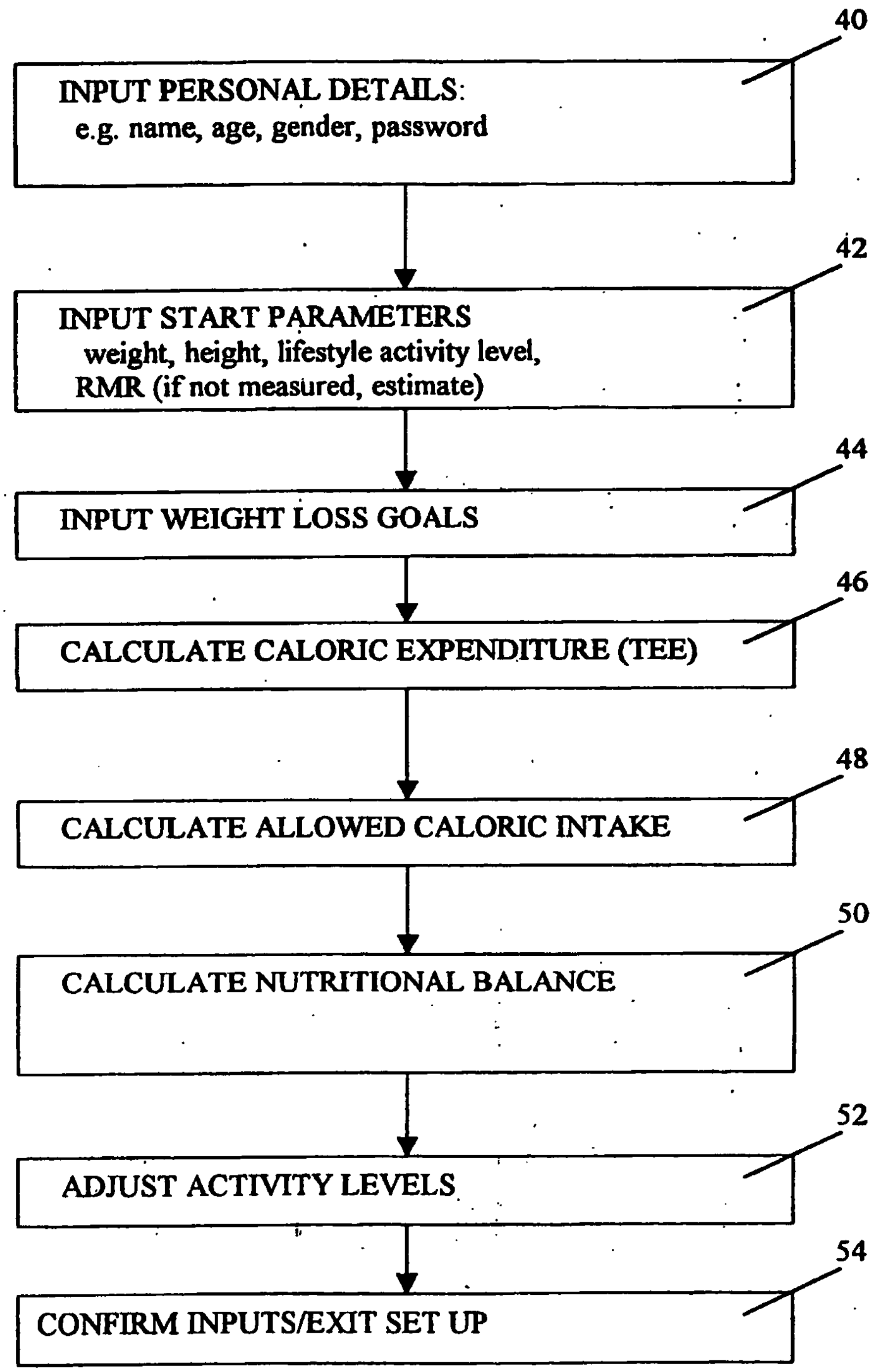

40
INPUT PERSONAL DETAILS:
e.g. name, age, gender, password
42
INPUT START PARAMETERS
weight, height, lifestyle activity level,
RMR (if not measured, estimate)
44
INPUT WEIGHT LOSS GOALS
46
CALCULATE CALORIC EXPENDITURE (TEE)
48
CALCULATE ALLOWED CALORIC INTAKE
50
CALCULATE NUTRITIONAL BALANCE
52
ADJUST ACTIVITY LEVELS
54
CONFIRM INPUTS/EXIT SET UP

Figure 2

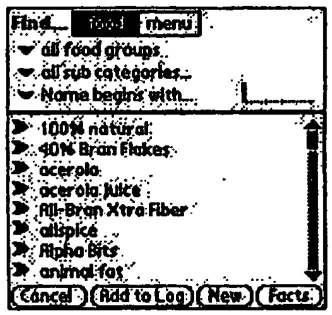

Find...
food
menu
all food groups...
all sub categories...
Name begins with...
100% natural
40% Bran Flakes
acerola
acerola juice
All-Bran Xtra Fiber
allspice
Alpha Bits
animal fat
Cancel
Add to Log
New
Facts

Figure 3

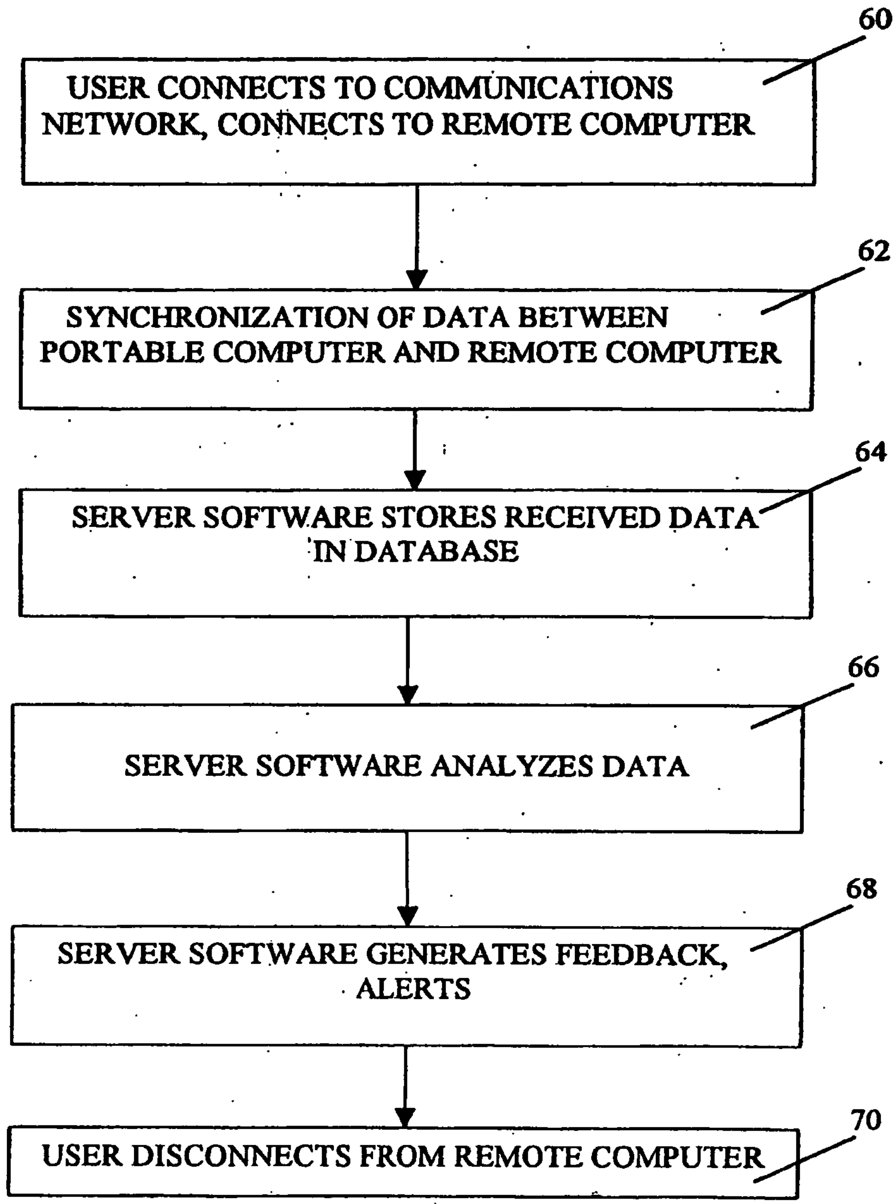

60
USER CONNECTS TO COMMUNICATIONS NETWORK, CONNECTS TO REMOTE COMPUTER
62
SYNCHRONIZATION OF DATA BETWEEN PORTABLE COMPUTER AND REMOTE COMPUTER
64
SERVER SOFTWARE STORES RECEIVED DATA IN DATABASE
66
SERVER SOFTWARE ANALYZES DATA
68
SERVER SOFTWARE GENERATES FEEDBACK, ALERTS
70
USER DISCONNECTS FROM REMOTE COMPUTER

Figure 4

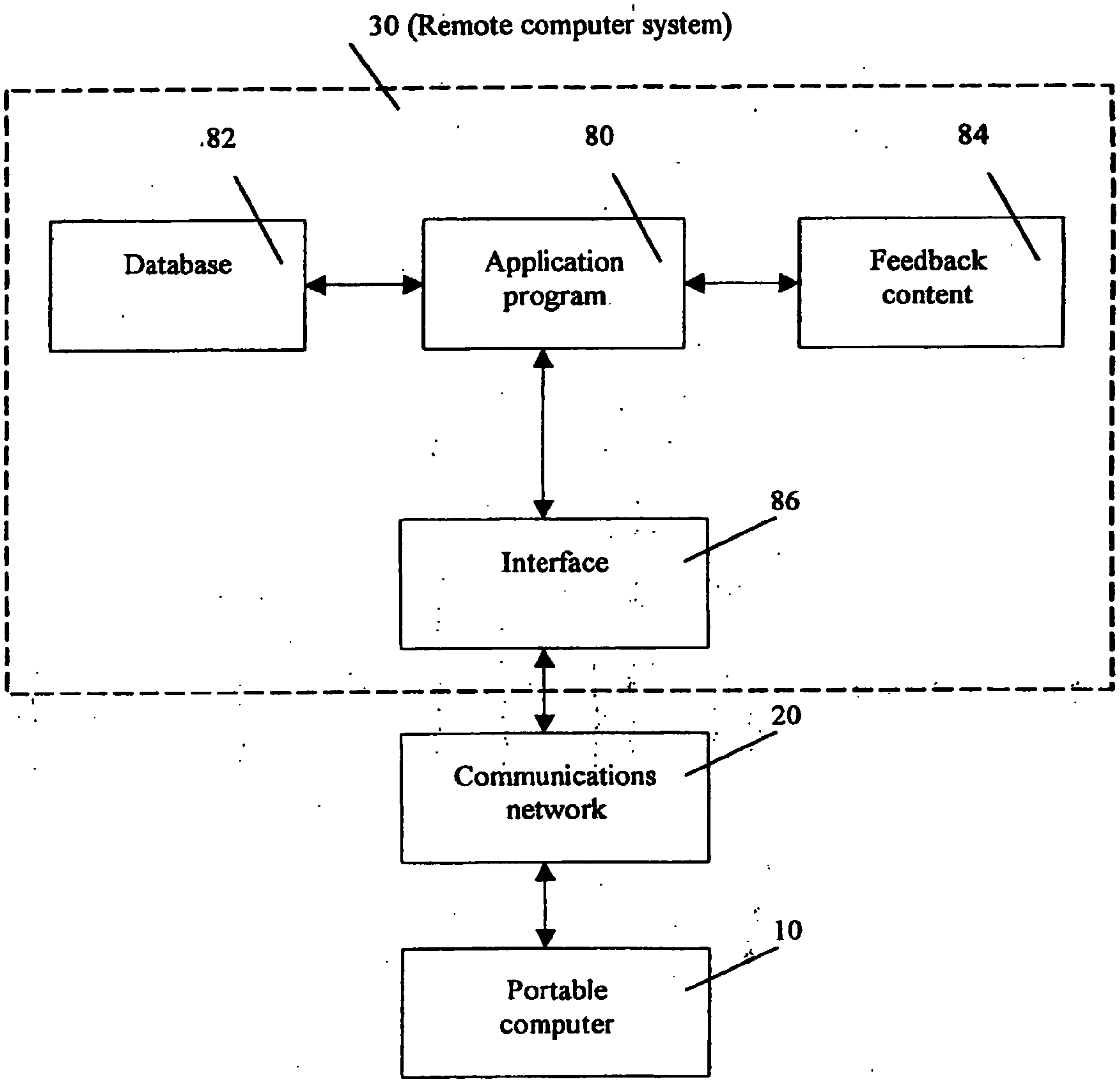

30 (Remote computer system)
82
80
84
Database
Application program
Feedback content
86
Interface
20
Communications network
10
Portable computer

Figure 5

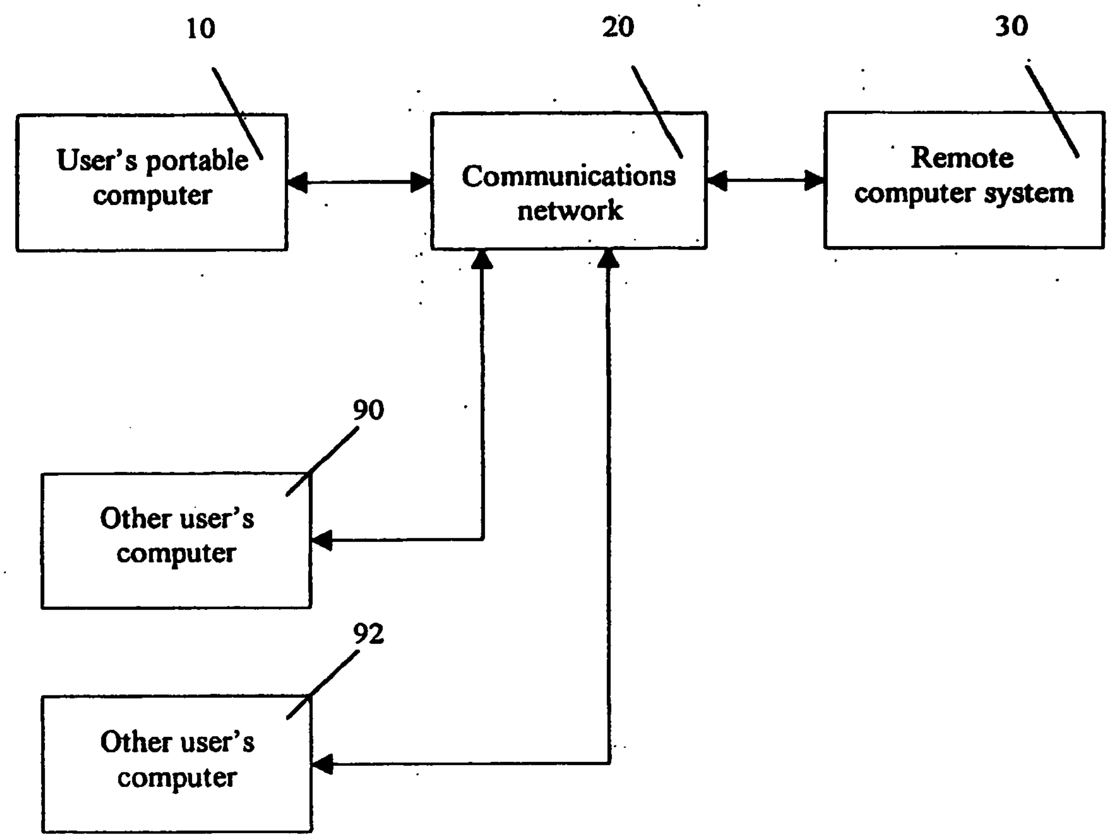

10
20
30
User's portable computer
Communications network
Remote computer system
90
Other user's computer
92
Other user's computer

Figure 6

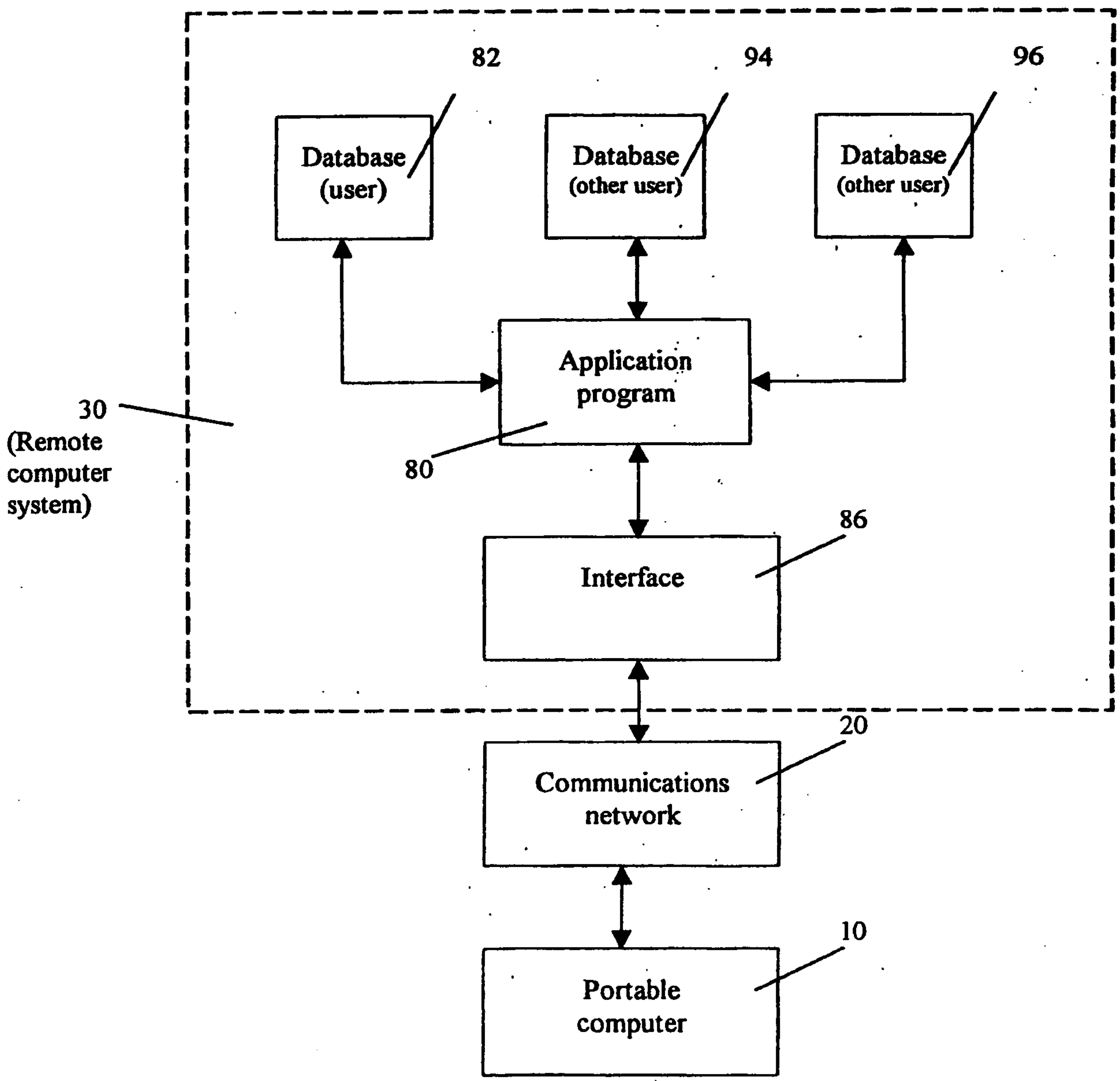

82
94
96
Database
(user)
Database
(other user)
Database
(other user)
Application
program
30
(Remote
computer
system)
80
86
Interface
20
Communications
network
10
Portable
computer

Figure 7

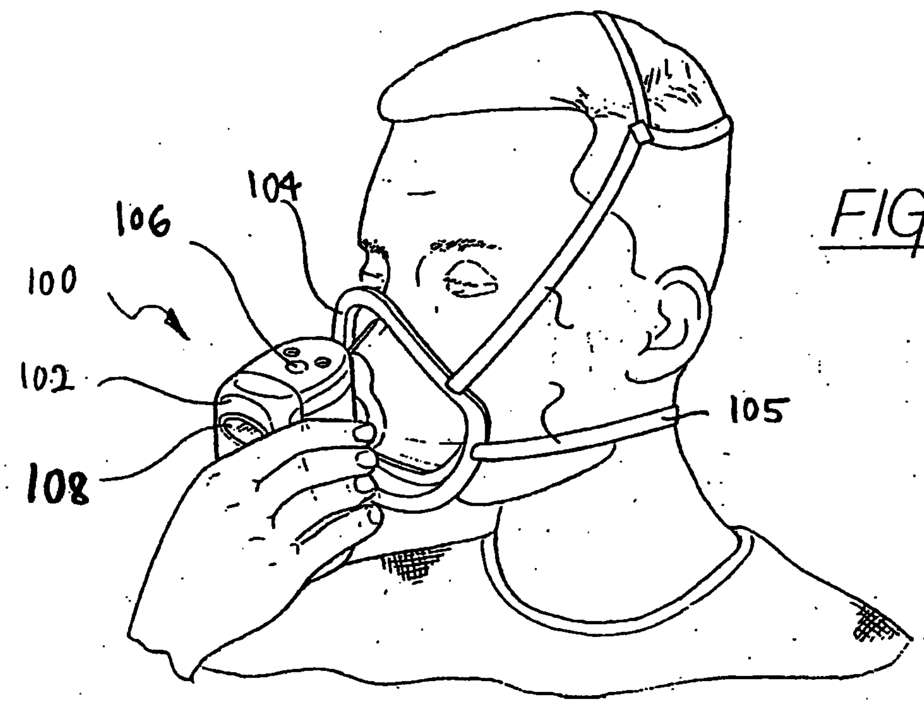
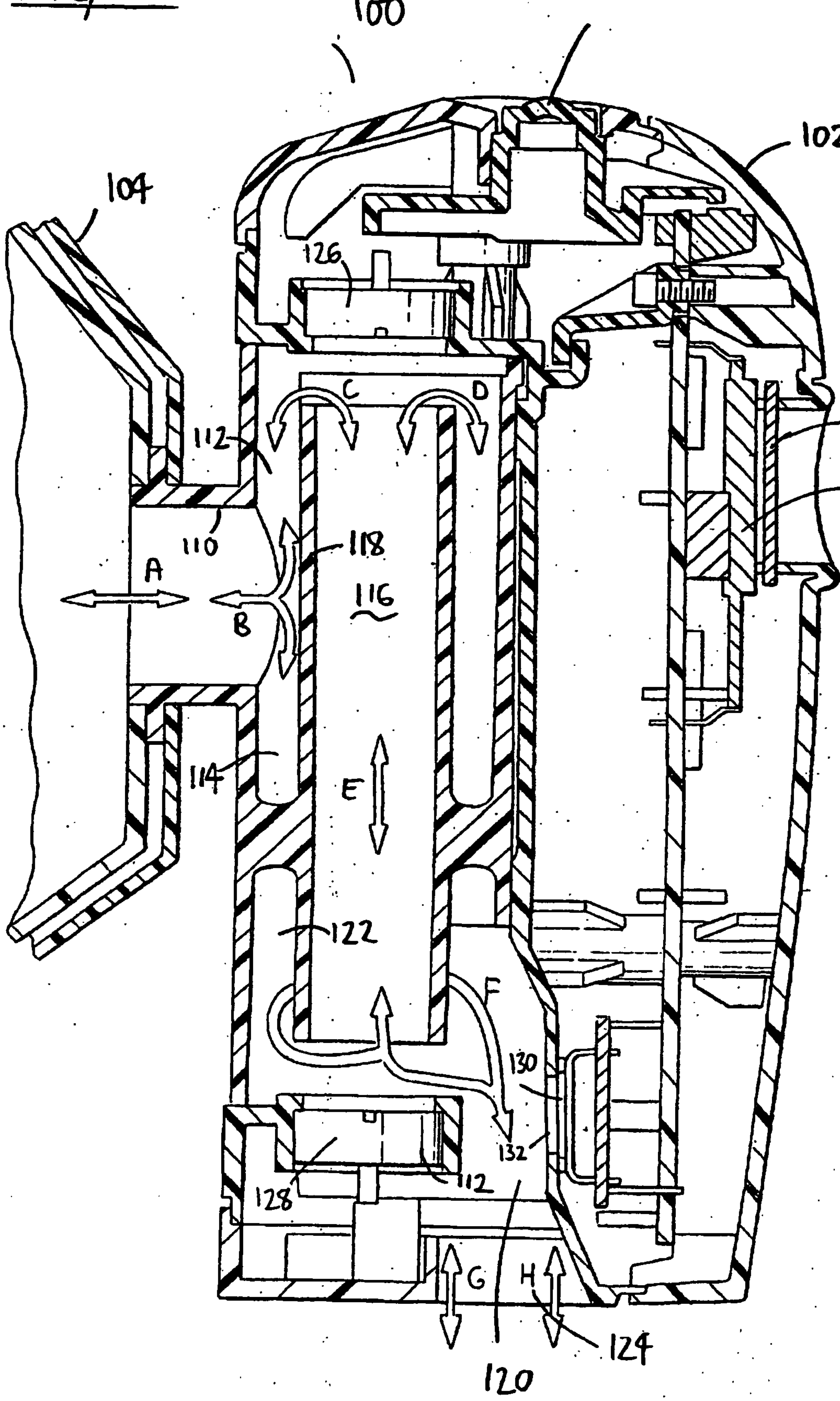


FIG - 8

FIG - 9


100
106
102
104
126
C
D
108
112
109
110
118
A
116
B
114
E
122
F
130
132
128
112
G
H
124
120

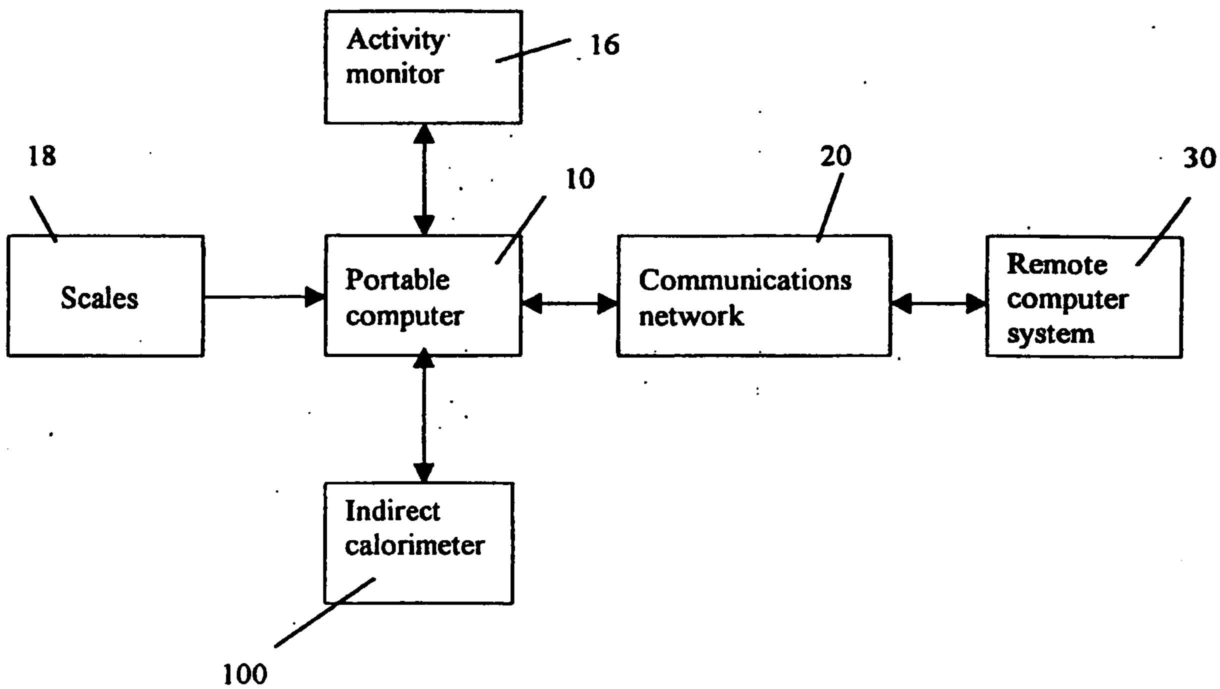

Activity monitor
16
18
10
20
30
Scales
Portable computer
Communications network
Remote computer system
Indirect calorimeter
100

Figure 10

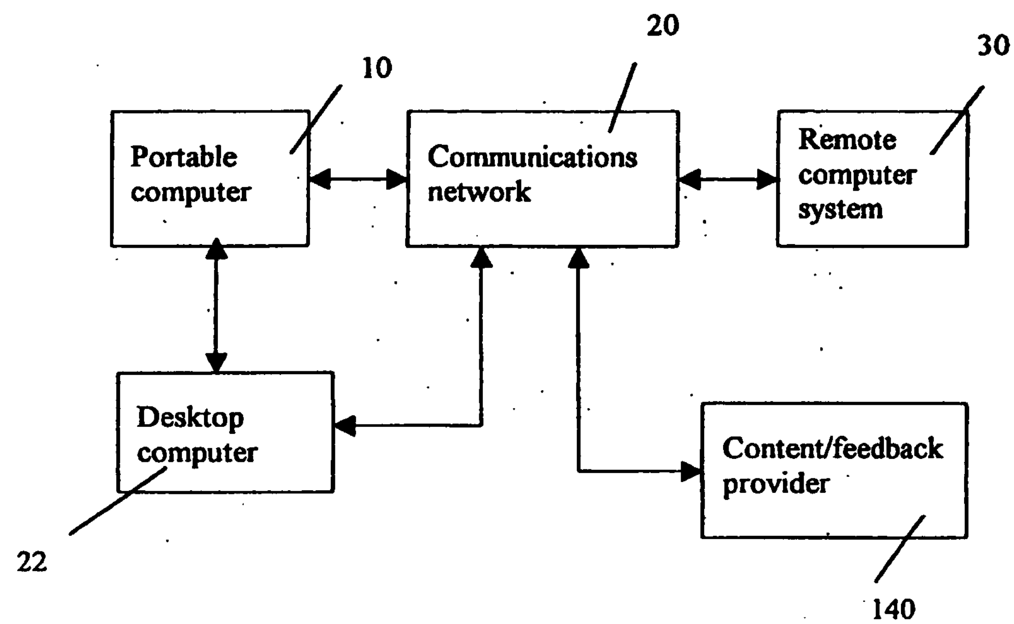

20
30
10
Portable computer
Communications network
Remote computer system
Desktop computer
Content/feedback provider
22
140

Figure 11

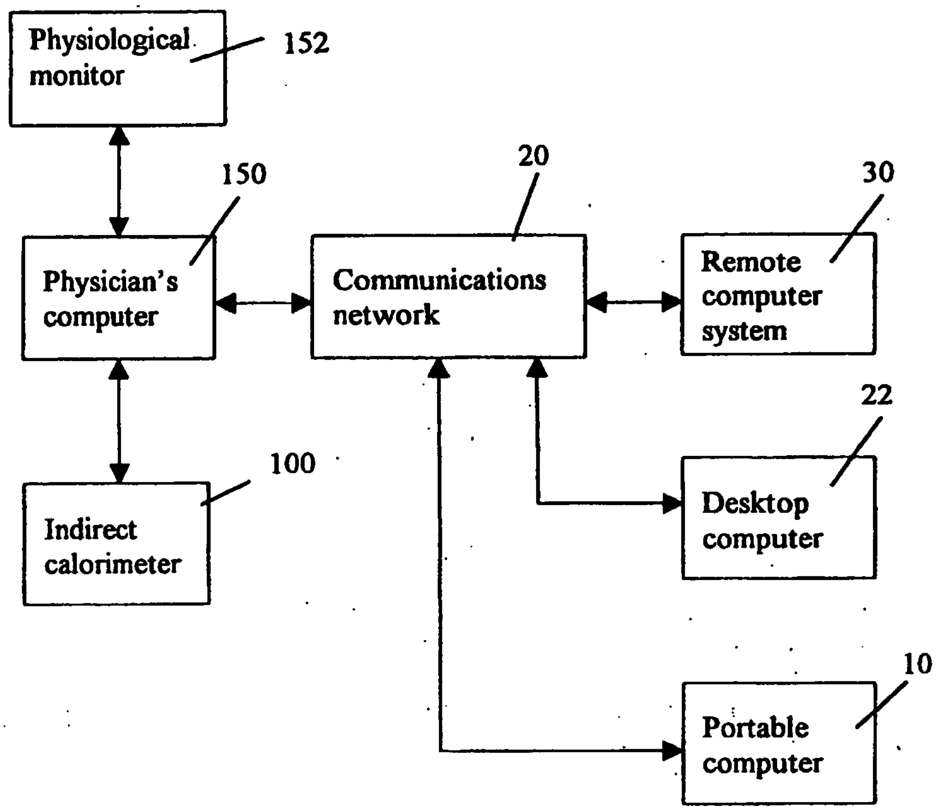

Physiological monitor
152
150
20
30
Physician's computer
Communications network
Remote computer system
22
100
Desktop computer
Indirect calorimeter
10
Portable computer

Figure 12

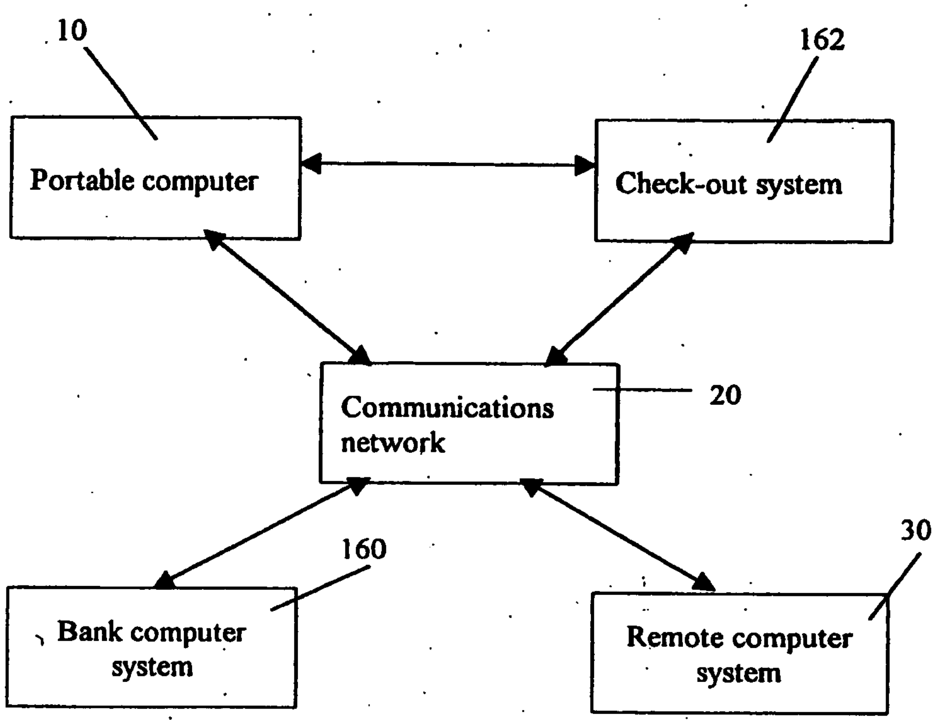

10
162
Portable computer
Check-out system
Communications network
20
160
30
Bank computer system
Remote computer system

Figure 13

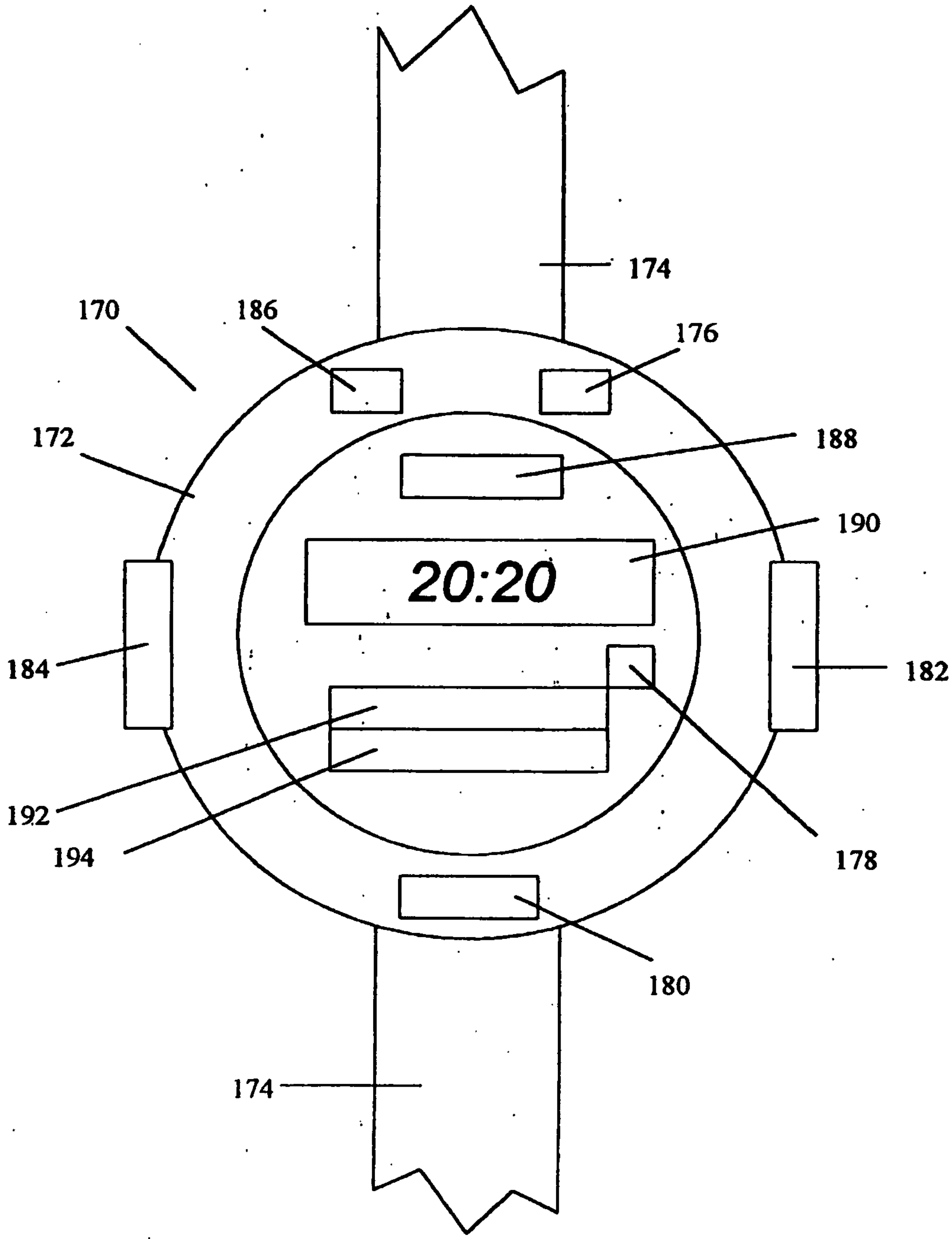


Figure 14

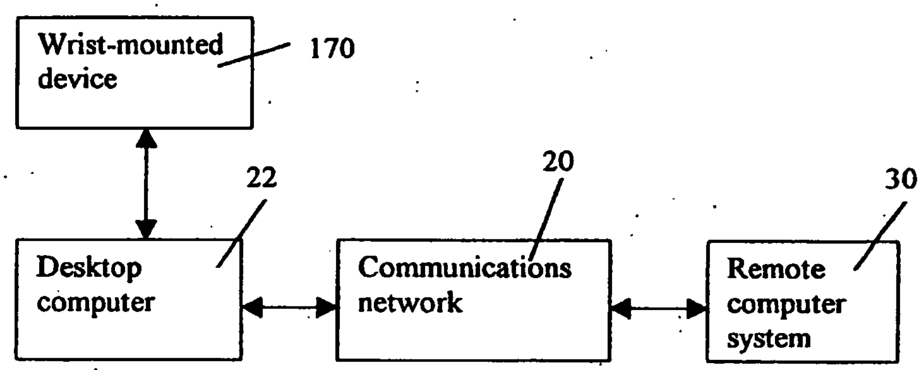

Wrist-mounted device
170
22
20
30
Desktop computer
Communications network
Remote computer system

Figure 15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/32331

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :G06F 17/60
US CL : 705/1
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : Please See Extra Sheet.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,954,640 A (SZABO) 21 September 1999, See Entire Reference	1-12
Y	US 5,947,868 A (DUGAN) 07 September 1999, See Entire Reference	1-12
Y,P	US 6,161,095 A (BROWN) 12 December 2000, See Entire Reference	1-12
X,P	US 6,059,692 A (HICKMAN) 09 May 2000, See Entire Reference	1-12

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

01 APRIL 2001

Date of mailing of the international search report

23 APR 2001

Name and mailing address of the ISA/US
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Facsimile No. (703) 305-3230

Authorized officer

SAM RIMELL James R. Matthews

Telephone No. (703) 306-5626

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/32331

B. FIELDS SEARCHED
Minimum documentation searched
Classification System: U.S.

705/1,2,3,4
482/4,8
600/300